FLUID DELIVERY APPARATUS WITH DELIVERY HOSE FLUSHING

The invention relates to measured fluid delivery apparatus.

Many different types of fluid delivery apparatus are known. One type consists of a tanker vehicle for use in transporting fluids, for example fuel oil, from a main storage tank to other storage tanks. Frequently one tanker vehicle has to carry a plurality of different fluids for delivery, for example, not only to domestic fuel tanks for use with central heating apparatus, but also to petrol stations for the storage of fuel for motor vehicles.

This requires separate storage compartments on the vehicle and also requires apparatus defining separate delivery paths to avoid cross-contamination between different fuels.

The invention provides fluid delivery apparatus comprising a mobile storage container having at least two compartments, for use in transporting at least two fluids from main storage tanks to subsidiary storage tanks at other locations, the apparatus having a single fluid flow path to deliver fluid, means to feed any one fluid along the flow path, and means to clear the flow path of the first fluid, before a second fluid is fed along the flow path.

The means to clear the flow path of a fluid may comprise means to delivery pressurised air along the flow path.

The means to deliver pressurised air may comprise a compressed air tank.

Preferably the apparatus is such that the quantity of first fluid cleared from the flow path is returned to an appropriate storage tank of the apparatus.

Preferably the apparatus has means to monitor the quantity of fluid that is delivered from the apparatus, the monitoring means being arranged to take

into account the quantity of first fluid which is returned to the apparatus by clearing of the flow path.

Preferably, the apparatus takes into account the quantity of fluid contained in the flow path between the compressed air tank and the outlet end of a dispensing nozzle of the apparatus.

Normally there will be an elongate flexible hose extending between the compressed air tank and the nozzle. During prolonged service, the length of this hose may be changed, for example if a portion of hose is damaged, requiring shortening of the hose to avoid the cost of replacing the entire hose.

Accordingly, the apparatus preferably has means to measure the quantity of fluid contained between the compressed air tank and the outlet end of the nozzle. The measuring means may include a flow monitoring valve associated with the nozzle.

Preferably the apparatus comprises electronic control means connected to various valves of the apparatus, arranged to reduce the number of decisions and actions which need to be taken by an operator, and also reduce the risk of incorrect or unauthorised operation of the apparatus.

By way of example, a specific embodiment of the invention will now be described, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of one embodiment of fuel tanker vehicle according to the invention;

Figure 2 is a logic diagram showing how the apparatus is controlled by the electronic control device of the apparatus; and

Figure 3 is a cross-sectional view through a flow monitoring valve of the apparatus.

The apparatus comprises a fuel tank 10 mounted on a mobile road chassis (not shown). The tank 10 is divided into five compartments, 11 to 15. Each compartment has an associated vent valve 11a to 15a, linked to an upper coaming 16 of the tank 10, the coaming having a pressure sensor 17 linked to the electronic control device 18.

Each compartment also has an associated foot valve 11b to 15b and each foot valve is connected by pipe work to an associated main valve 11c to 15c.

The main valves 11c to 15c can be arranged to communicate with a common manifold 19 which forms part of a single fluid flow delivery path for the vehicle. The path continues from the manifold via an entrained air detector 20, a turbine meter 21, a filter 22 and a liquid detector 23, until the path reaches a product pump 24. The single fluid delivery path then continues through a pneumatic isolation valve 25 to a delivery hose reel 26 containing a length of flexible hose having a trigger nozzle 27. The pump 24 is associated with a pump relief valve 24a and a pressure transducer 24b.

From each end of the manifold 19, pipe work leads via respective vent valves 28, 29 to a common vertical vent pipe 30 having an upper vent valve 31.

Another entrained air detector 32 is connected to the manifold 19. The manifold 19 also has a manifold pressure sensor 33.

Connected into the single fluid flow delivery path via a pipe 34 is a blow down air tank 35 controlled by valves 36, 37 and a pressure sensor 38. The air in the tank 35 is compressed by a compressor (not shown) which forms part of the transport vehicle.

The electronic control unit 18 comprises a register/controller 39 connected to all the sensors, and an associated solenoid control box 40, connected to all the valves. The solenoid control box 40 is also connected via lines 41 and 42 to the lock of a conventional guard bar (not shown) restricting access to the valves 11c to 15c until the appropriate time, and also controlling a product return lock via connection 42.

The control device 18 comprises an extremely efficient menu driven control system, which requires minimum involvement by the vehicle driver/operator and also substantially reduces the risk of incorrect operation, which might lead to cross-contamination of fuels, and also unauthorised operation, for example if the driver tries to delivery fuel to an unauthorised location.

The apparatus is controlled by the unit 18 to operate as illustrated in the logic diagram of figure 2. The logic boxes containing wording (e.g. main menu) i.e. box 50 relate to options controlled by the operator of the apparatus. The logic boxes containing reference letters A to H relate to operations controlled by the apparatus. Each step in the logic diagram will be described in turn.

The driver is initially presented with a main menu 50 which has the following options:

Loading
Discharging
Fleet fuelling

When the driver starts with an empty vehicle, and therefore has to load his compartments with different fuels from a storage depot, he selects the loading option on the main menu.

The driver is then presented with the sub menu 51 where he retrospectively inputs data saying which quantity of which product he loaded in the first compartment, and so on for subsequent compartments.

Alternatively, he can select a second choice from the menu 51, namely self loading. This causes a programme in the control unit 18 to choose products to be loaded from box 52 in the logic diagram and subsequently choose compartments from box 53.

When the necessary data has been inputted, the driver selects the start loading option after connecting a suction hose from the appropriate storage tank to an auxiliary suction port on the manifold 19. The trigger nozzle 27 is connected to a return port on one of the valves 11c to 15c and the trigger nozzle is opened. All the compartment valves are opened but the manifold valves remain power closed.

The first selected product to be loaded floods the manifold 19 and the pump pipe work. As the product enters, air escapes through the vent pipe 30.

When sensors 30, 20 and 23 give wet signals to the register/controller 39, the manifold vent valve 31 is closed and valve 25 is opened. When the flow starts a relief valve 24a of the pump 24 is energised. When flow stops, the pump relief valve is released. If no flow is detected for longer than 60 seconds then valve 25 is closed. The relief valve 24a can be used to direct flow from the pump 24 when pumping is required, or cause fluid to circulate within the pump when flow is not required.

When either a preset volume, or maximum compartment volume minus the calibrated volume is reached, the flow is slowed by opening the pump relief valve.

The driver closes the storage tank valve and opens the air vent. He disconnects the suction hose from the storage tank and feeds the product into the manifold. When sensor 32 gives a dry signal, the relief valve is opened to slow flow, when sensor 20 shows dry register/controller 39 freezes the display of quantity delivered.

The pump relief valve is then again energised to give full flow and when the sensors 32, 20 and 23 all give dry signals, then valve 25 is closed and relief valve fully opened. At this point valve 36 of the blow down air tank is closed and valve 37 is opened when the pressure in air tank 35 is reduced to a given value within a preset time then valve 37 is closed and valve 36 is opened. The compressed air entering the delivery line from the tank 35 blows the line clear of the first product.

The calibrated volume contained within the pumping system, which has been delivered into the compartment under the action of pump and compressed air, is added to the current value frozen on the unit 18 so that the unit now displays the total quantity loaded.

The system is now dry, ready for loading of the next compartment and this continues until self loading is complete.

At the end of loading, logic box 54 provides closure of all tanker valves and the product return guard bar locks, and if desired a ticket may be printed at 55 to give a hard copy of transactions completed.

The loaded vehicle then travels to a destination where at least one product is to be discharged. The driver then selects the discharging option from menu 50 and from a sub-menu selects whether he is to deliver an unlimited quantity or a preset quantity. If the unlimited quantity option is selected, then the driver has to chose the relevant fuel and compartment and then opt to start delivery.

Once the driver has taken the option to start delivery the controller 39 the driver opens relevant compartment valves, manifold and the manifold vent valve 31. Product floods the manifold and pump pipe work and when sensors 32, 20 and 23 give wet signals to the register/controller 39, air escaping through the vent pipe 30, the manifold vent valve is closed and valve 25 is opened. When flow starts, the pump relief valve is energised and when flow stops, the pump relief valve is released. If no flow is detected for longer than 60 seconds, then valve 25 is closed.

If the quantity of product to be delivered is greater than that contained in a single compartment, it will be necessary to change to another compartment containing the same product (see box 56 of the logic diagram). The height of liquid in a compartment can be measured by the differential pressure between the coaming pressure sensor 17 and the manifold pressure sensor 33. At a predetermined liquid height above an foot valve the liquid flow is reduced by opening the pump relief valve, preventing vortexing of the liquid.

When sensor 32 gives a dry signal, pump relief valve is released and the valve 25 is closed. The compartment valves are closed and the manifold valves are closed, the manifold vent valve 31 being opened.

The second compartment valves are now opened and also the manifold valve. When sensor 32 gives a wet signal, air having escaped through the vent pipe 30, valve 31 is closed, valve 25 is opened and the pump relief valve is energised.

Once the nozzle has been closed and the desired quantity has been delivered the driver signals end of delivery by pressing the appropriate control (logic box 57). The steps set out in logic box 58 then take place.

The register/controller 39 freezes display of the quantity delivered. The relevant manifold valve is closed and the vent valve 31 is opened. The product return and guard bar locks are released.

The trigger nozzle 27 is connected to the product return port on the manifold by the driver and when the nozzle is opened, valve 25 is opened and the pump relief valve is energised. When sensors 32, 20 and 23 give dry signals to the register/controller 39 the valve 25 is closed again.

The valves 36 and 37 of the pressurised air tank 35 are then operated in the same sequence as described above, causing the pipe work to be blown clear. The calibrated volume of the pumping system is subtracted from the quantity previously displayed by the register/controller 39 so that the total quantity delivered will accurately appear on the register/controller. The pump system is again now dry and delivery is complete. The product return and guard bar locks and compartment valves are again closed.

If the preset quantity option is selected then the register/controller 39 automatically goes through the control steps namely choosing the product, choosing the compartment and starting delivery if that compartment has sufficient product. If the compartment does not have a sufficient quantity then an additional compartment is chosen to provide the necessary additional product and delivery is then started.

The necessary operational steps are described in box 59 of the logic diagram.

The necessary compartment valves, manifold valve and manifold vent valve are opened. Product floods the manifold and pump pipe work. When sensors 32, 20 and 23 give wet signals, air having escaped through the vent pipe as previously described, valve 31 is closed and valve 25 is opened. When flow starts, the relief valve of the pump is energised.

When flow stops the pump relief valve is released. If no flow is detected for longer than 60 seconds then valve 25 is closed.

If the preset quantity is greater than the volume in the compartment initially selected, the apparatus automatically goes through the change of compartment procedure previously described with respect to box 56 of the logic diagram.

When the preset quantity is reached, minus the calibrated volume of the pumping system (from nozzle to manifold), plus a slow down volume, the pump relief valve is opened to slow flow to a predetermined flow rate until the preset quantity minus the calibrated volume of the pumping system is reached. The pump relief valve is then released and valve 25 is closed. Compartment valves and manifold valves are closed and the manifold vent valve 31 is opened.

The register/controller 39 freezes the display of quantity delivered. Pump 25 is opened and the pump relief valve is energised. When sensors 32, 20 and 23 give dry signals the valve 25 is closed.

The valves of the blow down air tank 35 are then again operated as described above to clear the line. As the calibrated volume of fuel within the pumping system has now been added in the usual way, the register/controller 39 shows the total quantity delivered. Once again the pump system is dry and delivery is complete.

The fleet fuelling option relates to a situation where fuel from the tanker vehicle may be used to re-fuel a fleet of vehicles, for example a fleet of school buses. The logic boxes shown at the left hand side of Figure 2 enable the operator to choose which product is to be delivered to each vehicle, choose a first compartment from which to draw fuel, choose one or more follow on compartments if the first compartment is not going to contain sufficient fuel,

then carry out the delivery process, finally ending delivery and printing a record ticket if necessary.

The steps set out in the logic boxes, relating to operations controlled by the apparatus, are as follows:

STEPS A

Driver connects suction hose from third party storage tank to auxiliary suction port on manifold.
Release Product Return guard bar locks.
(Trigger nozzle is connected to product return port on manifold by driver and nozzle opened).
Open all compartment valves (Manifold valves remain power closed).
Product floods manifold and pump pipe work.
When sensors LD 1.2 and 3 give wet signals to LC2000 (air has escaped through vent pipe), close manifold vent valve, open ball valve BV1.
When flow starts, energise pump relief valve.
(When flow stops release pump relief valve if no flow is detected for longer than 60 seconds then close ball valve (BV1).

When either a Pre-set volume or max compartment volume minus calibrated volume is reached, slow flow by opening the pump relief valve.
(Driver closes storage tank valve and opens air vent., Disconnects suction hose from storage tank and feeds product into manifold(. When (LD1) gives continuous dry signal, with (LD2) wet LC2000 freezes display of quantity delivered. If (LD2) gives entrained air signal then (BV1) closes.
Energise pump relief valve.
When sensors LD1, 2 and 3 give dry signals to LC2000 close ball valve (BV1).
Close valve (BDV1) and then open valve (BDV2).
When Blowdown air tank has reduced pressure to a given value within a preset time then close valve (BDV2) and then open (BDV1).

Calibrated volume of pumping system is added to LC2000 delivered quantity and displays total quantity delivered.

Pump system is dry and self loading is complete.

STEPS B

Close product return guard bar lock and compartment valves.

STEPS C

Open compartment valves, manifold valve and manifold vent valve (AV1).

Product floods manifold and pump pipe work.

When sensors LD1, 2 and 3 give wet signals to LC2000 (air has escaped through vent pipe), close manifold vent valve, open ball valve (BV1).

When flow starts, energise pump relief valve.

When flow stops release pump relief valve. If no flow is detected for longer than 60 seconds then close ball valve (BV1).

STEPS D

CHANGE OF COMPARTMENT

(Liquid height is measured by the differential pressure between the Coaming Pressure sensor (CPS1) and Manifold Pressure sensor (MPS1). At a pre-determined liquid height above the Foot valve the liquid flow is reduced by opening the pump relief valve, preventing vortexing of the liquid).

When (LD1) gives a dry signal, release pump relief valve, close ball valve (BV1), close compartment valves and close manifold valve, open manifold vent valve (AV1).

Open second compartment valves and manifold valve.

When wet leg sensor (LD1) gives wet signal (air has escaped through vent pipe) close manifold vent valve (AV1), open ball valve (BV1) and energise pump relief valve.

STEPS E

LC2000 freezes display of quantity delivered.
Close Manifold valve and open vent valve (AV1).
Release Product Return guard bar locks.
(Trigger nozzle is connected t o product return port on manifold by driver and nozzle opened).
Open ball valve and energise pump relief valve.
When sensors LD1, 2 and 3 give dry signals to LC2000 close ball valve (BV1).
Close valve (BDV1) and then open valve (BDV2).
When Blowdown air tank has reduced pressure to a given value within a preset time then close valve (BDV2) and then open (BDV1).
Calibrated volume of pumping system is added to LC2000 delivered quantity and displays total quantity delivered.
Pump system is dry and delivery is complete.
Close product return guard bar lock end compartment valves.

STEPS F

Open compartment valves, manifold valve and manifold vent valve (AV1).
Product floods manifold and pump pipe work. When sensors LD1, 2 and 3 give wet signals to LC2000 (air has escaped through vent pipe), close manifold vent valve (AV1) and open ball valve (BV1). When flow starts, energise pump relieve valve.
When flow stops release pump relief valve if no flow is detected for longer than 60 seconds then close ball valve BV1.

Preset is greater than volume in Compartment.

See CHANGE OF COMPARTMENT.

At the preset quantity minus the calibrated volume of the pumping system (from nozzle to manifold) plus a slow down volume, open pump relief valve slowing flow to a predetermined flow rate until the Preset quantity minus the calibrated volume of the pumping system is reached.
Release pump relief valve and close ball valve (BV1).
Close compartment valves and manifold valve. Open manifold vent valve (AV1).
LC2000 freezes display of quantity delivered.
Open ball valve and energise pump relief valve.
When sensors LD1, 2 and 3 give dry signals to LC2000 close ball valve BV1.
Close valve (BDV1) and then open valve (BDV2).
When Blowdown air tank has reduced pressure to a given value within a preset time then close valve (BDV2) and open (BDV1).
Calibrated volume of pumping system is added to LC2000 delivered quantity and displays total quantity delivered.

Pump system is dry and delivery is complete.

STEPS G

Open compartment valves, manifold valve and manifold vent valve (AV1).
Product floods manifold and pump pipe work.
When sensors LD1, 2 and 3 give wet signals to LC2000 (air has escaped through vent pipe), close manifold vent valve, open ball valve (BV1).
When flow starts, energise pump relief valve using 60 psi pressure setting.
When flow stops release pump relief valve if no flow is detected for longer than 60 seconds then close ball valve BV1.

STEPS H

LC2000 freezes display of quantity delivered.

Close Manifold valve and open vent valve (AV1)

Release Product Return guard bar locks.

(Trigger nozzle is connected to product return port on manifold by driver and nozzle opened).

Open ball valve (BV1) and energise pump relief valve.

When sensors LD1, 2 and 3 give dry signals to LC2000 close ball valve (BV1).

Close valve (BDV1) and then open valve (BDV2).

When Blowdown air tank has reduced pressure to a given valve within a preset time then close valve (BDV2) and then open (BDV1).

Close all compartment valves and product return guard bar.

Pump system is dry and delivery is complete.

Note:

During delivery when flow stops for longer than 30 seconds generate a subtotal of quantity delivered. Repeat as required. When "end delivery" is taken generate grand total of quantity delivered.

Because of the use of the blow down air tank 35, it is possible to provide a clean dry fuel delivery pipe system, each time a product is changed, thus reducing the risk of any cross fuel contamination. Although the fuel that is blown out of the pipe work system by the pressurised air is returned rather than wasted, and after final loading or delivery reading is provided by the register/controller 39 because of the fact that the quantity of fuel contained by the pipe work is pre-calibrated. In all instances, the register display on the register/controller 39 will register zero until the quantity of product moved is equal to the calibrated volume of the pump system between the nozzle and the manifold. This quantity consists of the flooded volume of the manifold and pipe work down to the valve 25 plus a metered quantity. This ensures that the register reading will represent exactly any product leaving the nozzle. If the

blow down air tank 35 is prevented from releasing air pressure in a designated time then the register/controller 39 will register incomplete delivery. The register/controller 39 will then automatically re-try to blow down.

It would be possible to make an initial calculation of the quantity of product which is to be returned during the blowdown procedure. However, the actual quantity may vary over prolonged service, for example if the length of the hose 26 has to be shortened, for example because of damage to part of the hose. Accordingly, the preferred embodiment of the apparatus is provided with means to actually measure this quantity of product each time the apparatus is used.

This is achieved by the use of the fluid monitoring valve shown in Figure 3. The valve comprises a body 60, which is mounted in the trigger nozzle 27. Within the body 60 there is a spring loaded valve poppet 61 having a bleed orifice 62 therethrough.

When the trigger nozzle 27 is first opened to deliver product, the relevant length of fluid flow path is dry and contains air. This air is able to exit the nozzle 27 through the bleed orifice 62 of the valve poppet 61.

When all the air has been expelled and product reaches the nozzle 27, the pressure of the product lifts the valve poppet 61 off a valve seat 63 of a body 60 so that the product can emerge from the nozzle 27.

The change from air flowing through the bleed orifice 62, to product flowing through the valve seat 63, results in a pressure change which is detectable by a pressure transducer (not shown). Thus the apparatus can use the time gap between opening of the nozzle 27 and the change in pressure, to measure the actual quantity of product within the Blowdown portion of the apparatus.

In addition to providing the operator with great versatility and ease of operation, the apparatus also guards against various types of unauthorised operation. With very simple apparatus for example, it would be possible for an operator to trap some product in the delivery pipe with the intention of illegally delivering this to an unauthorised location later on. This is not possible with the apparatus according to the invention because the relevant portion of the flow path has to be blown clear, and checked by the apparatus to be dry, before the vehicle can move onto another location.

The apparatus can also cope with a frustrated delivery. If for example a customer has ordered 500 units of product, but then it turns out in practice the customer's tank can only take 450 units, then by returning the product as previously described, an accurately delivered quantity can be achieved.

During any delivery situation except fleet fuelling, the apparatus is programmed to terminate delivery and print a ticket if flow stops for more than three minutes. This is to ensure that the operator cannot cheat one customer, and fraudulently deliver to an adjacent accomplice by temporarily interrupting delivery to one house in order to illegally deliver some of the fuel to an adjacent house.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.